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Forecasts that Communicate: Assessment, Development, and Delivery of Probabilistic Forecasts that Foster Easy, Accurate, and Reliable Interpretation

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Project Description

The primary objective of this project is to improve the ease, accuracy, and reliability with which seasonal forecast products are interpreted. Supporting objectives are to:

- Foster ongoing, iterative relationships between research, operational forecasting, and water management communities.
- Enable the efficient provision of customizable forecast formats by operational forecasters or information intermediaries (e.g., extension agents).
- Provide feedback tools to the operational forecasting and social science community to track forecast formats and elements preferred by diverse stakeholders.
- Improve water managers' perceptions of climate forecast credibility, through more accurate understanding of the contents of forecast products.

Our project focuses on two components. The first is to quantitatively assess multiple forecast formats for easy, reliable, and correct interpretation. From this effort we hope to identify specific product elements that consistently improve (or confound) forecast communication, which can then be applied to (or eliminated from) a broad range of forecast products. The second component of our proposed work is the implementation of dynamically interactive Internet-based webtools that will allow users to customize a forecast product to best fit their cognitive style, technical capabilities, and decision making needs.

Project Activities

During this project period, we made substantial and significant progress both in assessing forecast formats, and in building the foundation for dynamic forecast formatting tools.

Assessment of Forecast Formats

During this reporting period, we developed a collection of various seasonal forecast products issued using different formats, focusing on official products from the National Weather Service (NWS) Climate Prediction Center (CPC), International Research

Institute for Climate and Society (IRI), Environment Canada, and Australian Bureau of Meteorology. We also developed several alternatives to these products, focusing on alternative terminology and supporting interpretive graphics (e.g., bar charts, pie charts, regional scale indicators). While we focused on tercile-based products, we also included CPC Probability of Exceedance (POE) plots.

Working with Niina Haas, Assistant Staff Scientist in the Core Office of the University of Arizona's (UA) Climate Assessment for the Southwest (CLIMAS) project, we developed a series of formal survey instruments. The questionnaires were pre-tested using several volunteers within CLIMAS and the UA Institute for the Study of Planet Earth (ISPE). Survey questions focused on the respondent's existing familiarity and use of climate forecasts, and comprehension of a single forecast product. Questions were identical across questionnaires, or as similar as possible consistent with the specific product format. Questions were targeted toward determining whether respondents could correctly:

- identify the variable depicted (e.g., temperature, temperature anomaly, probability, probability anomaly),
- identify the forecast categories (e.g., above and below median, terciles),
- identify the forecast reference period,
- identify probability ranges,
- identify situations lacking forecast opportunity,
- identify the appropriate spatial scale,
- translate forecast information into alternative terminology, and
- extend forecast information to related concepts (e.g., statistical meaning).

We coordinated with two professional societies to implement the survey protocol at their annual meetings. The protocol consisted of distributing a survey to each meeting participant in a pseudo-random order, with a small fraction of people being asked to complete their survey in an interview setting. The goal was 100% distribution of the surveys, with enough returns to assess the statistical significance of results for each question. Each person was asked to complete a single survey, precluding learning of forecast concepts across multiple products. The interviews consisted of the respondent answering the questions on the survey, in the presence of an interviewer, while also being prompted to explain why they selected specific answers or how they determined a specific answer.

Our first field survey was conducted at the Annual Meeting of the American Water Resources Association (AWRA), 7-10 November 2005, in Seattle, WA. This meeting involved about 475 participants who attended sessions on diverse water resources management topics. Our second survey was conducted at the Annual Meeting of the American Meteorological Society (AMS), 29 January – 2 February 2006, in Atlanta, GA. This meeting involved several thousand participants who attended sessions on many aspects of meteorology, climatology, and hydrology.

Both organizations were cooperative in allowing the surveys to be administered. However, the AWRA meeting style and size was much more successful. At the AWRA meeting, we were allowed to set up a table near registration for the entire meeting, from which we could personally hand out and request returns from meeting participants at every break throughout the meeting. At the AWRA meeting, we received nearly 150 completed questionnaires and completed interviews for each forecast product. At the AMS meeting, we were allowed to place a stack of surveys at each registration booth and have a survey return box nearby. However, the AMS meeting registration is so busy and distracting to participants, that almost no one saw or took the surveys. We then placed surveys at key locations (e.g., near the email access and daily newsletter distribution sites) throughout the week, but very few surveys were picked up by participants. Upon questioning several participants, it became clear that people were distracted by other meeting activities and didn't see the surveys. We received fewer than two dozen returned surveys from the AMS meeting.

Key Results:

- A meeting the size of the AMS Annual Meeting is too big for effective survey administration. There are too many distractions for attendees to notice surveys placed at the registration counters. A meeting the size of the AWRA Annual Meeting allows personal distribution of surveys, although with significant effort throughout the meeting to solicit survey returns. The return rate from the AWRA meeting would have been lower without the 'hustle and harass' approach.
- Respondents at the AWRA meeting had high potential for considering climate variability, but the current forecast formats discourage people from engaging with the product. This is exemplified by interview comments saying, in essence, "This product must not be applicable to my work, because otherwise I would understand it."
- Current forecast products are being extensively misinterpreted. Experienced forecast users had more incorrect answers than non-users.
- No forecast format was more effective than any other, but the POE format, as currently delivered by the CPC, is notably ineffective. The only effective alternative format of those tested was the highly simplified POE product.
- The major forecast format issues are (1) complexity without clear structure and (2) persistent language problems (e.g., the use of 'above' and 'below' with regard to tercile forecast categories, and identifying when forecasts of opportunity are not warranted).

Key findings:

- Information itself, within a forecast product, is insufficient. People have trouble coordinating and connecting information, and disconnected product elements create confusion.
- People are confused and tentative about basic statistical principles.

Recommendations:

- A forecast product should structure a person's interaction with the information.
- A forecast product should have explicit reinforcement of basic principles of statistics and probability.

Dynamic Forecast Formatting Tools

During this reporting period, we developed a demonstration prototype of a key component of a dynamic forecast formatting tool, now part of the UA Climate Information Delivery and Decision Support System (CLIDDSS). While substantial work remains, we were able to develop the databases, interfaces, and integrative software code for allowing an information intermediary or end user to:

- efficiently interact with multiple distributed websites delivering forecast or other information products over time,
- obtain automated retrieval of their preferred forecast product parameters, and
- convert preferred products into flexible PDF format, which facilitates the transfer of the online survey questionnaire and preferred forecast formats to stakeholders without Internet access.

Reporting and Technology Transfer

During this period, we reported on project results in the following presentations:

Hartmann, H.C. and N. Haas, 2006. Assessment of probabilistic forecasts using field surveys of resource management professionals: preliminary results. Fourth Annual Climate Predication Applications Science Workshop, NWS Climate Services Division, Tucson, AZ, 21-24 March.

Hartmann, H.C., 2006. A climate information delivery and decision support system. Fourth Annual Climate Predication Applications Science Workshop, NWS Climate Services Division, Tucson, AZ, 21-24 March.

Based in part on the work conducted in this project, H. Hartmann also was invited to serve on a panel on “Decision Making, Partners, and Stakeholders” at the Fourth Annual Climate Predication Applications Science Workshop, NWS Climate Services Division, Tucson, AZ, 21-24 March.